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United States Department of Agriculture,
BUREAU OF ENTOMOLOGY,
L. O. HOWARD, Entomologist and Chief of Bureau.

THE HESSIAN FLY.

(*Mayetiola* [*Cecidomyia*] *destructor* Say.)

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Probably no other insect causes more damage to the wheat crop of the United States than the Hessian fly, though the chinch bug is doubtless a close second. During years when it is excessively abundant, hundreds of thousands of acres of wheat may be either totally destroyed or so badly injured as to reduce the yield 50 to 75 per cent, and the monetary losses expressed in dollars would run far up into the millions. This insect is an old depredator, in the sense that it has long been known to ravage our wheat fields, yet farmers are, in many cases, still at a loss regarding the best methods of warding off its devastation.

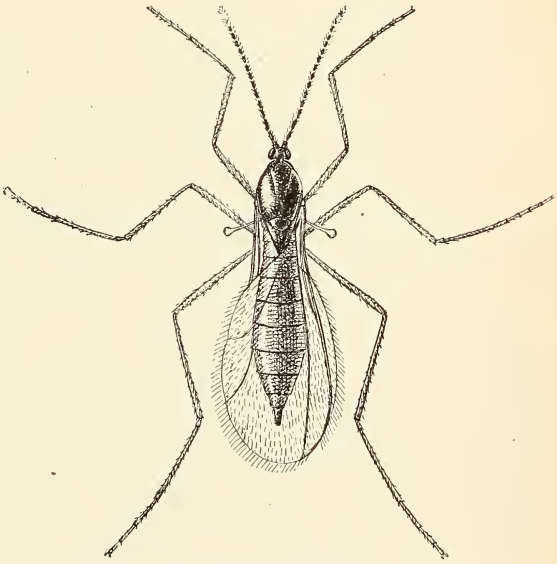

Fig. 1.—The Hessian fly (*Mayetiola destructor*): Adult female, much enlarged (original).

EARLY HISTORY IN AMERICA.

The common name, "Hessian fly," was long ago bestowed upon this insect by Americans, because of its having committed some depredations on Long Island, New York, in 1779, in the vicinity of Lord Howe's old encampment of three years before. The Hessian merce-

naries who constituted a part of this army were much despised, both at home and in America, and, on the supposition that these soldiers had brought the pest with them from their native country in the straw used for their bedding while en route, it was given the obnoxious name of "Hessian fly." Whether or not this theory of its introduction was well founded can never be either substantiated or disproven, and all that can now be said is, that the pest was imported, probably from some trans-Atlantic country and some time during the latter half of the eighteenth century. As a matter of interest, it may be stated that, in some quarters, the more ignorant Tory element of those days claimed that General Washington was responsible for this pest. It was not technically described until 1817.

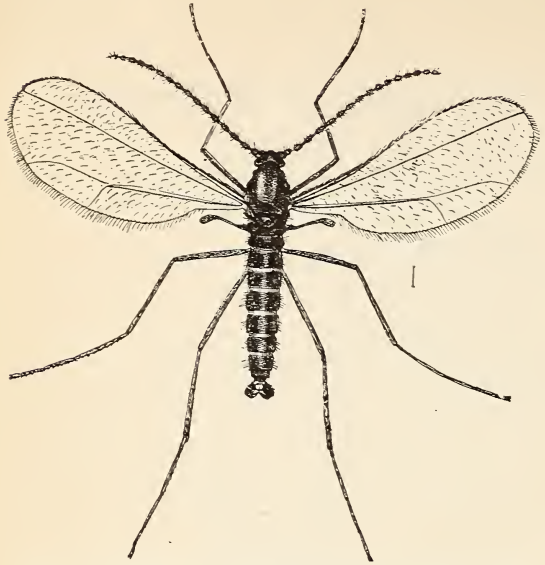

FIG. 2.—The Hessian fly: Adult male, much enlarged (from Marlatt).

DESCRIPTION OF THE INSECT.

The fly itself (fig. 1, female; fig. 2, male) is very small, being only about one-tenth of an inch long, the body of an obscure dark color, and the form much like that of a very small mosquito. The abdomen of the female (fig. 1) is red, or yellowish when first hatched from the "flaxseed," the color varying with age, the posterior segments terminating in a compressed cylindrical, very minutely hairy ovipositor, capable of great extension. The male (fig. 2) is smaller, more slender, and in color generally darker than the female, the abdomen terminating in a somewhat intricate organ composed of a set each of outer and inner claspers.

The egg (fig. 3) is very minute, being only about one-fiftieth of an inch in length, cylindrical, roundingly pointed at the ends, glossy translucent, and slightly reddish, this color deepening with development.

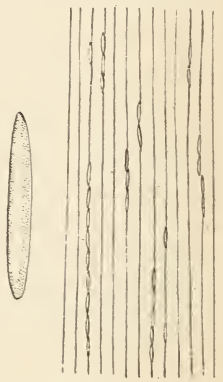

FIG. 3.—Egg of Hessian fly, greatly enlarged; section of leaf of wheat, at right, showing eggs as usually deposited, less enlarged (original).

The larva or maggot (fig. 4), when newly hatched, is a little smaller than the egg, with a slightly reddish tinge; later, as it increases in

size, it is at first white and afterwards greenish white, clouded internally by flaky white.

The flaxseed (fig. 6).—This is the name given to the insect after the larva has reached its full growth and the skin has hardened and turned brown, forming a covering known as a puparium. There is at this time a minute, brown, forked process on the underside of the anterior end of the larva, known as the "breastbone" (fig. 5), the use of which is not fully understood. It is not present, however, until the larva enters the flaxseed state. Within this "flaxseed" it transforms first to a pupa (fig. 7), and from this to an adult fly. The term "flaxseed" is applied partly because of its brown color and partly because it is more or less flattened, thus giving it somewhat the appearance of a flaxseed.

FIG. 4.—The Hessian fly: Larva before "flaxseed" is formed, much enlarged (original).

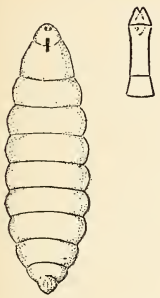

FIG. 5.—The Hessian fly: Larva taken from "flaxseed," much enlarged, with "breastbone" still more enlarged at right (original).

WHERE TO FIND THE DIFFERENT STAGES.

From the foregoing descriptions it will be observed that, during the life of this insect, it is found in four very different forms, so entirely unlike in appearance as to confuse the average farmer.

The eggs (fig. 3), which may be easily seen by one with fairly good eyesight, are generally placed in the grooves of the upper surface of the leaves, though they are occasionally found on the underside of the leaf. When the young wheat plant is just pushing through the ground, the egg is sometimes placed on the outside, because no leaves are available. The young larva is slightly smaller than the egg, and as soon as it is hatched it makes its way down the leaf and behind the sheath. In case of young wheat it descends to just above the root, but after the plants have begun to joint it can go no farther than the base of the sheath belonging to that particular leaf, which is always at the joint. Where excessively abundant, the larvæ will frequently be found on the lower stem ranged one behind the other, the anterior end of one pushed slightly under the posterior end of the one in advance. Very often this position is maintained throughout the entire development of the larva (figs. 4 and 5), and the flaxseeds (figs. 6 and 10) still retain the same relative position. The fall brood of larvæ and the overwintering flaxseeds are to be found just above the roots (fig. 10),

FIG. 6.—The Hessian fly: Puparium or "flaxseed," much enlarged (original).

FIG. 7.—The Hessian fly: Pupa taken from "flaxseed," greatly enlarged (after Marlatt).

except in cases where the young plant has become disintegrated and separated at the point of attack in the fall or the plants have been heaved out by the action of freezing and thawing, in which case they may be scattered about on the surface of the ground.

The young make their way down the plant head foremost, and so remain until before pupating, when they reverse their position in the flaxseed and are then situated head upward, and thus pass into the pupal stage. Before the fly issues, however, if the flaxseed is not situated conveniently for its escape, the pupa will push itself, if possible, to such a point, and frequently empty pupa skins may be observed protruding from under the sheaths of the leaves.

The fly itself is not easily observed until one becomes familiar with its appearance, and this will account for the great variety of insects that are continually mistaken by farmers for the Hessian fly. Much of this difficulty may be obviated if farmers will look for an insect like that shown in figure 1, but very minute and somewhat resembling a very small mosquito. During warm days, in the egg-laying season, the flies may be observed flying about in the young wheat, alighting upon the leaves. In cooler days, or in early morning while a heavy dew is on, they will be down among the leaves, or even on the ground.

LIFE HISTORY.

At present all indications point to the probability of the Hessian fly being two-brooded, at least during favorable seasons, over its entire area of distribution in the United States.

In the South the two broods are the most widely separated, while in the North, in the regions of spring-wheat growing, they seem to follow each other in quick succession.

LIFE HISTORY IN REGIONS OF FALL-WHEAT GROWING.

Throughout the fall-wheat-growing sections the fly passes the winter in the young wheat, mostly in the flaxseed stage, but also to some extent as from two-thirds to full-grown larva. It is difficult to estimate the number of these larvæ that will winter over and remain alive until spring, owing to the fact that it is impossible to determine whether they are alive or dead until they begin to decay. But where we have attempted to rear them, even though apparently alive, comparatively few adults have been obtained, though of course this mortality would probably vary somewhat with the severity of the weather during winter.

In spring (from March, in Georgia and South Carolina, to May, in Michigan) the flies escape from the flaxseeds and deposit their eggs on the wheat, and the young from these develop to flaxseeds before harvest, passing the summer in the stubble. The flies from overwintering larvæ come on later; and it is quite probable, also, that some of the very earliest deposited eggs may give rise to adults at about this

time; thus, owing to this overlapping, during some seasons and in some localities, there appears just before harvest what has by some been considered a supplementary second brood.

In autumn the time of appearance of adults as between North and South is reversed. In northern Michigan the adults of the fall brood are abroad, under normal meteorological conditions, during the last days of August and first days of September. In Georgia and South Carolina, under the same conditions, it may be the last of November or the first of December before they have all left the stubble. Thus has the species adapted itself to the prolonged southern summer, during which there is little or no food for the larvæ. While there are stragglers, the major part of the brood will appear and disappear within the space of a few days, probably within a week, and the flies, by preference, will deposit their eggs on the younger plants, those of one or two leaves seeming to suit them best. At this time the young larvæ make their way downward nearly or quite to the roots (fig. 10). The normal outcome of this brood is that the individuals reach their development as larvæ, pass into the flaxseed stage, and pass the winter as such on the young wheat plants. But here again the earliest deposited eggs may produce adults before the winter sets in, and the delayed individuals occurring at this time may unite and another supplementary brood, as it has been termed, may be produced. The economic significance of this so-called brood depends much on the weather, as, if winter sets in before the larvæ have sufficiently matured to withstand its rigors, these must necessarily perish, while, if the mild autumn weather is greatly prolonged, more or less of them may winter over uninjured.

LIFE HISTORY IN SPRING-WHEAT REGIONS OF THE NORTHWEST.

The statements here made are based largely on the careful investigations carried out by Mr. George I. Reeves, a special field agent of this Bureau, during the season of 1905. This single season may have been an exceptional one, in that the spring was backward, the summer wet, and the mild autumn weather continued later than usual. The results must not, therefore, be taken as wholly conclusive.

In North Dakota the insect winters in the flaxseed stage in both stubble and volunteer wheat, chiefly the former. Egg laying begins late in May, and during seasons with plenty of rain the second brood follows the first in quick succession, being reenforced by the continued emergence of flies from stubble of the previous year. Here the summer conditions are different from those in the East and South, and the breeding season extends from about May 20 to October 1, or throughout the entire summer. In other respects the habits of the insect do not seem to differ from what they are in the fall-wheat-growing section of the country.

Outside of America the Hessian fly occurs in North Africa, western Asia, Europe, British Islands, and New Zealand. In the Dominion of Canada Doctor Fletcher has found it from Prince Edward Island to Indian Head, Saskatchewan. On the Pacific coast it probably occurs from southern California to British Columbia; but as no exact investigations have been made there, this statement is to be considered as only approximately correct.

Our previous notions of the distribution of this insect over the country east of the Rocky Mountains will have to be revised. The accompanying map (fig. 8) will show the extent to which this revision becomes necessary. The original of this map appears in Bulletin 16.

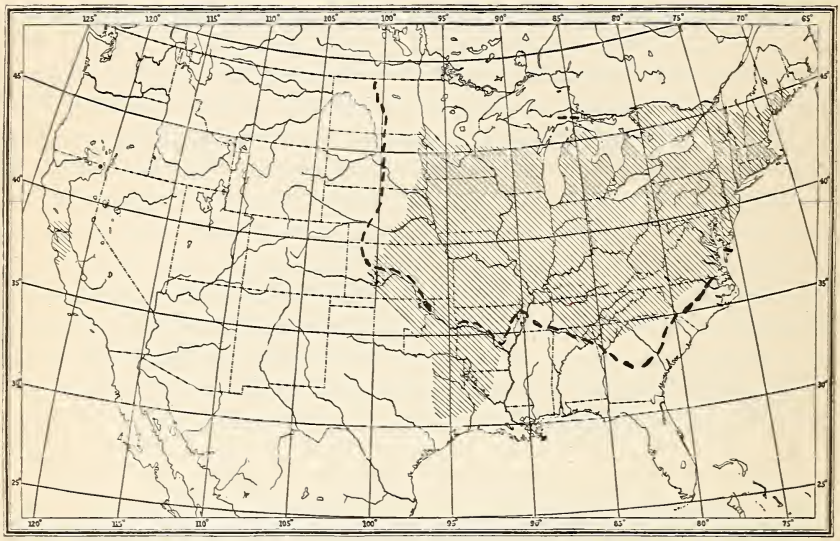

FIG. 8.—Map showing distribution of the Hessian fly in America (altered from Osborn).

new series, of this Bureau (issued in 1899). The heavy broken line indicates the present western and southern limits of Hessian fly distribution based on our latest observations and data furnished by Professor Bruner, of Nebraska, and Mr. R. I. Smith, entomologist of the Georgia State crop pest commission. This is believed to be approximately correct. It also seems to show that the insect must have been first introduced into the Pacific coast region in or with articles of inland commerce, and (unless it be found to infest native grasses) that it did not reach there by natural diffusion, a point that has not before been definitely stated so as to be clearly understood.

Experimental sowings of wheat near Sault Ste. Marie, Mich., during the last two years do not reveal its presence there, and no attempt

has been made to study its occurrence in the spring-wheat-growing sections of Maine. While its absence in some parts of the country between the Platte River, in Nebraska, and the Canadian boundary line might be attributed to a lack of its food plant, this will not hold in southwestern Kansas and Oklahoma, as in those localities it seems to suddenly terminate in the midst of a wheat-growing section, and where this grain has been cultivated for at least twenty years. Strange as this may at first appear, Doctor Merriam, of the Biological Survey, informs the writer that he finds several parallel cases in the distribution of some of the smaller mammals.

FOOD PLANTS.

While the female fly will often deposit her eggs on grass, or even weeds, the larvæ, so far as known, survive only on wheat, barley, and rye, proportionately in the order mentioned. From time to time "flaxseeds" closely resembling those of this insect have been observed on the stems of several native grasses, but adults reared from them have not been considered as belonging to this species, owing to supposed structural differences, and no experiments have been made to ascertain whether or not it is possible for larvæ of the Hessian fly to survive on these grasses. Doctor Forbes some years ago failed to induce the insect to breed in either redtop, bluegrass, foxtail, or orchard grass—species on which "flaxseeds" had, however, not been found.

Flaxseeds resembling those of Hessian fly have been found on Elymus, Agrostis, Bromus, and Agropyron, in California, by Mr. Koebele, and on the latter also in Indiana, by Mr. W. J. Phillips, a field agent of this Bureau. Besides, Doctor Lindeman found similar flaxseeds on timothy and *Agropyron repens* in Russia.

EFFECT OF LARVÆ ON THE PLANT.

The effect of the larvæ on a young wheat plant is very marked and becomes observable soon after the young reach the stem under the sheath. Once he has observed it, any farmer can readily detect an infested plant, or a single infested tiller may be as readily detected in a cluster without taking the trouble to remove the plant from the ground.

For the purpose of comparison, illustrations are given of an uninfested young plant (fig. 9) and an infested young plant (fig. 10). An uninfested plant is of a more slender growth, the green color is lighter, with a slight tinge of yellow, the stems are more or less visible, and the central unfolding leaf is present. The whole plant is inclined to droop and the tillers spread out and cover the ground. An infested plant is without stem and the leaves are broader, usually shorter and of a deep bluish-green color, somewhat resembling those of oats. The

plant stands more erect, and, in fact, is but a mass of short overgrown leaves that usually kill with the first frost. Figure 10 shows a young tiller starting out from below the part attacked by the fly. If this tiller were to be attacked after it appeared above ground, there would follow the same appearance as in case of the original plant; that is to

FIG. 9.—Healthy young wheat plant (original).

say, the leaves would become broader and of a darker color. The foregoing statement will apply to a severe attack on fall wheat in spring and on young spring wheat. The only exception in the appearance of infested young plants is in the case of the hard wheats, whose foliage is broader and of a darker color, but the erect position will

still enable the observer to detect the infestation. Of course later on the infested plants change to yellow and then brown, but the darker color and rank growth of leaf always precede this.

In summer, in both spring and fall wheat, the effect of the fly is to

FIG. 10.—Young wheat plant infested by the Hessian fly (original).

cause the straw to break over before harvest. It is then said to be "straw fallen."

IMMUNE OR DISTASTEFUL VARIETIES OF WHEATS.

There is no such thing as "fly-proof wheat." Most wheats will suffer when the plants are young, regardless of variety. In experimental sowings a variety that seems to escape attack one year may suffer

the next; and, while the insect may prefer certain varieties over others, this all comes to naught in years of serious ravages or where the supposed distasteful variety is in a condition more satisfactory to the insect at the time of oviposition. It is doubtful, however, if this can be said of the attack of the second brood on the more matured plants, as it is quite noticeable that the ranker-growing varieties with strong, stiff straw are the least affected. Then, too, among fall wheats in the northern part of the country it is quite essential that a wheat plant be able to send out tillers from the old roots of plants killed by the fly (fig. 10), and that these tillers prove hardy enough to withstand the winter. Therefore, in selecting varieties of wheat with a view to evading Hessian-fly attack, the farmer will do well to ignore statements on this point from those who have seed to sell and select from the varieties known to do well in his locality such as are of strong, vigorous growth, hardy, and with a stiff straw. For some reason the durum or macaroni wheats do not seem to attract the fly, at least not the second brood. In going over fields of this kind of wheat in sections where other spring wheats were suffering from attack by this pest, it was rarely found on a stem of macaroni wheat, while any straws of other varieties growing from seed that had become intermixed were almost invariably infested. Whether this will hold good in case of the young plants it is as yet impossible to say, because of the difficulty of telling to what varieties the young plants belong. Infested plants have been found in fields of young macaroni wheat in some considerable numbers; but these plants may have been of other varieties, as the fields had been used for other varieties the year before, and besides the seed itself may have been impure.

METEOROLOGICAL EFFECTS.

All who have carefully studied the Hessian fly, under various field conditions during a series of years, have noted that weather conditions have an important influence on the insect. Especially is this true in its economic relations to the grains it attacks; hence, in the application of preventive measures, these weather conditions become of vital importance.

Many farmers place much stress on the effect of cold weather or even of frosts in terminating the flies' work in the fall, and it is for this reason that many try to delay wheat sowing until after there has been a sharp frost. The facts are that the females will be abroad and ovipositing in freezing weather, and Mr. W. J. Phillips has found by experimentation that the eggs will remain in a temperature of 36° F. for seventy-two hours with no other effect than to delay their hatching that much longer. This is about the temperature at which

frosts would occur. Indeed, the writer has observed eggs hatching during the day in the fields when there were frosts nearly every night. Whether or not the larvæ from these would get sufficiently advanced to pass the winter would, of course, depend upon later weather conditions. In the North these much-belated larvæ are killed off by cold weather.

The immunity of the late-sown wheat from attack by the fly is not due to frost, but to the fact that, by the time severe frosts usually occur, most of the flies have appeared and gone.

The most marked influence of climatic conditions on this insect is seen in the effect of heat and drought, and especially of the two combined. In the South it is the long summer that so widely separates the two broods. Drought has a similar effect on the development of the insect as it has on the germination of the seed which produces its food; thus, dry weather in the late summer and fall tends to keep the insect in the flaxseed stage—a fact of special importance in the North, where it is imperative to get the wheat sown early enough to enable the plants to stand the winter. Under exceptional conditions, such as in a dry room, flaxseeds may be kept for a year, or even two, but when moistened the flies will soon after emerge. So in the fields they will, during a drought, remain in the flaxseed state for a considerable time after they would appear under normal conditions, and only appear soon after rains have moistened the soil.

NATURAL ENEMIES.

There can be no doubt that parasites play a most conspicuous part in the natural control of the Hessian fly, and if we only knew the whole truth of the matter we should find that these minute friends of the farmer are worth many times their weight in gold. Not infrequently one species of these parasites will overcome the pest in a neighborhood so effectively as almost to exterminate it. Several times the writer has found, in attempting to breed Hessian fly from young wheat plants that had been killed by the larvæ, that hundreds of these parasites would emerge from the flaxseeds, while only an occasional fly could be obtained. Nearly all of these deposit their eggs in the bodies of the maggots, but the fully developed parasites emerge from the flaxseeds.

Professor Osborn [a] has enumerated six species of these parasites, not including the English species *Entedon epigonus* Walker. *Polygnotus minutus* Lindm., which occurs in Russia, France, and England, is in

[a] 1898: Bul. 16, n. s., Div. Ent., U. S. Dept. Agric., pp. 28–29.

America represented by *Polygnotus hiemalis* Forbes (fig. 11), perhaps the most useful of any in this country. It is very minute, and Mr. Reeves has counted over forty of the larvæ within a single flaxseed. It is black, with yellow feet, and the legs are dark brown, banded with yellow. The writer has again and again reared this in great numbers from fall wheat infested by the fly and witnessed the sudden check sustained by the pest the following spring. It is owing to this more than to any other influence that the Hessian fly is now being held in check in the spring wheat regions of the Northwest. Perhaps the next most useful parasite is *Eupelmus allynii* French (figs. 12, male, and 13, female). This is generally distributed over the country and affects both the Hessian fly and the joint-worm. It is larger than the preceding; the body is black, with a greenish luster, and the legs are more or less yellow. *Merisus destructor* Say (fig. 14) occurs in Europe, England, and America, but not in such profusion with us as to afford the same relief to the farmer as in the case of the two preceding. It also is black, but with a bluish green metallic reflection, and the legs are black, banded with yellow. *Platygaster herrickii* Pack. (fig. 15) is very minute, shining black in color, and is supposed by many to attack the egg of the fly, but there is still some doubt regarding this. *Bœotomus subapterus* Riley (fig. 16), as the name implies, has aborted wings in some individuals, while others are fully winged. The head and thorax are of a dark greenish metallic luster, and the legs honey-

FIG. 11.—*Polygnotus hiemalis*, much enlarged (original).

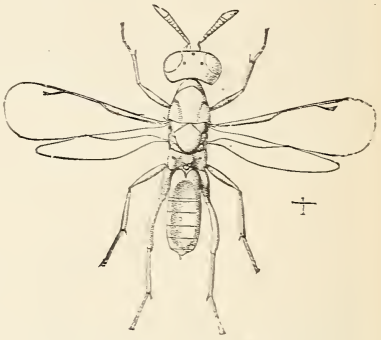

FIG. 12.—*Eupelmus allynii*: Male, much enlarged (from Riley).

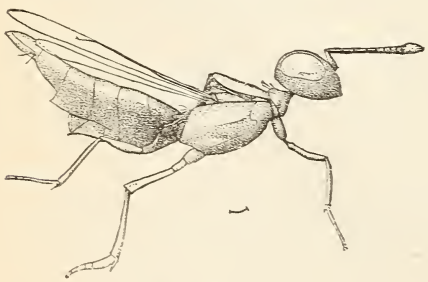

FIG. 13.—*Eupelmus allynii*: Female, much enlarged (from Riley).

yellow. It is generally less abundant than some of the others, but sometimes individuals are quite numerous. Besides these, several undescribed species have been recorded from the northwestern part of the country. The influence of these minute parasites in regulating the world's wheat supply is not at all understood, and it is doubtful if wheat could be successfully raised were they all to be suddenly swept out of existence.

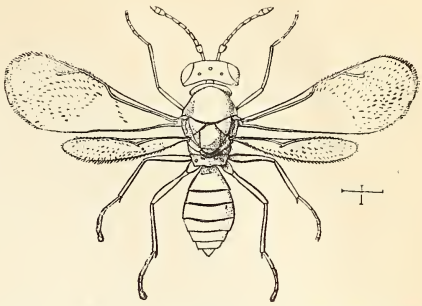

FIG. 14.—*Merisus destructor*, much enlarged (from Riley).

REMEDIAL AND PREVENTIVE MEASURES.

Of remedies there is little to be said, since after the pest becomes established in a field it can not be reached by any measure likely to destroy it. The application broadcast of some quick-acting fertilizer containing a large percentage of phosphate, made as soon as general infestation is apparent (see fig. 10), will cause the plants to tiller more freely and give them sufficient vigor to withstand the winter, and thus increase the number of healthy stems the following spring. Any other means that could be employed having a similar effect would be a remedial measure.

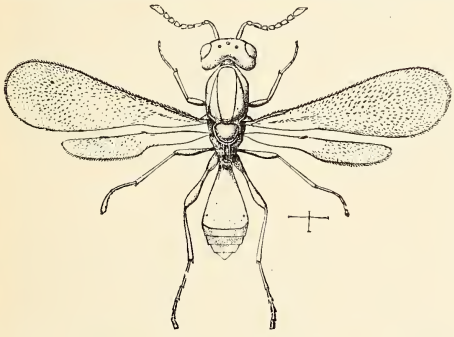

FIG. 15.—*Platygaster herrickii*, much enlarged (from Riley).

All practical measures must necessarily be in the nature of preventives, looking (1) to the elimination of the pest in the young wheat in the fall, and (2) to the increasing of the vigor of the young plants in order to enable them to counteract the insect's effect, when present. Under the first come late sowing, rotation of crops, burning of the old stubble, and the destruction of volunteer wheat. Under the second should be classed the enrichment of the soil, its thorough preparation, and selecting and properly sowing the best seed.

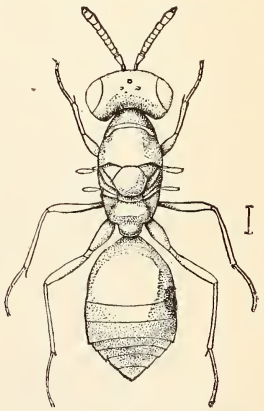

FIG. 16.—*Bœotomus subapterus*, much enlarged (from Riley).

LATE SOWING.

By late sowing as here recommended is meant moderately late sowing of fall wheat in any locality, for extremely late sowing, which has sometimes been advised, would be even worse than early sowing. The later appearance of the fly in the fall, as we pass from the north south-

ward, has already been explained. At present the Bureau of Entomology is conducting experiments in fall wheat sowing in nine States, covering approximately the country between latitude 33° and 46°. Here wheat is being sown every ten days during September, October, and November, year after year, with the expectation of determining the approximate date of safety for seeding in the fall to evade attack of the fly. While these experiments have not been going on for a long enough time to give results sufficiently definite, covering all variations in the weather during these months, it is safe to say that wheat may probably be sown, without danger from Hessian fly attack, in northern Michigan soon after the first of September; in southern Michigan and northern Ohio, about September 20; in southern Ohio, after the first week in October; in Kentucky and Tennessee, October 10 to 20; in Georgia and South Carolina, October 25 to November 15. So far these dates are only approximate, and serve to show in a general way about the time when the fall brood of the fly will have largely disappeared over the wheat belt east of the Mississippi River. As the larger part of the fall brood appears and is gone within a week, it is possible for a farmer to so time his seeding as to avoid it, and this is by far the most practical and effective preventive measure that can be applied.

CROP ROTATION.

Aside from the general benefits to be derived from crop rotation, it compels the Hessian fly, when it emerges from the stubble in the fall (or spring in the Northwest) to travel a greater or less distance to reach young wheat plants.

If, during this season of migration, storms or heavy winds occur, these frail creatures will be driven about or beaten down until a comparatively small number survive to reach their destination. On the other hand, if they are not obliged to leave the field where they emerge, this mortality will be vastly lessened.

BURNING STUBBLE.

This is the most efficient measure of all, as fire will reach and destroy not only the Hessian fly but all other insects infesting the stubble, including the joint-worm. Unfortunately, it can not be generally carried out. Over a large portion of the Middle West timothy and clover are sown, either with the wheat or during late winter or early spring, and therefore stubble-ground can not be burned over. Fields not followed by grass or clover can usually be burned over if the grain is cut rather high at harvest and a mower is run over the field and the mown grass, weeds, and stubble allowed to dry for a few days just before the burning. This is much the more feasible measure in the Northwest, and ought to be more generally followed.

DESTRUCTION OF VOLUNTEER WHEAT.

Perhaps the importance of this measure is best illustrated by the condition frequently observed in fields of young wheat in the fall, where every volunteer plant is infested and the sown grain is entirely free from attack. The volunteer plants were above ground in time to enable the fly to deposit her eggs on them, with the result that large numbers of flaxseeds will go through the winter and the flies therefrom will deposit their eggs on the plants which constitute the crop itself. Thus the growth of volunteer plants menaces, to a certain degree, the crop of the following year, precisely as does a field sown too early more seriously menace adjoining fields that are uninfested in the fall. This destruction of volunteer plants by plowing, disking, or otherwise must take place before the larvæ have matured in order to be effective.

ENRICHING THE SOIL.

While it may seem "far fetched" to bring forward as a preventive measure the enrichment of the soil, a fertile soil will produce plants that will withstand with little injury attacks that will prove disastrous to plants growing on an impoverished or thin soil. This is because a fertile soil will enable an infested plant to tiller freely, and these tillers will have sufficient vitality to withstand the winter and send up head-producing stems in the spring. It is also chiefly on the thin or impoverished soils that the difficulty of sowing late enough to evade the fall attack and at the same time secure a growth sufficient to withstand the winter is encountered, and whatever can be done to obviate this difficulty will constitute a preventive measure.

PROPER PREPARATION OF THE SOIL.

It matters little whether a soil has much or little fertility if that fertility is bound up in clods or hard lumps out of reach of the rootlets of the young plants. Early plowing and thorough working and compacting of the soil will eliminate the lumps and clods and produce a finely pulverized, compact, moisture-conserving seed bed, from which, as soon as rootlets are sent out from the seed kernel, the shoot will begin to draw nourishment. This will give vigor to the plants and thus enable them, by freely tillering, to outgrow a light attack of the fly that otherwise might prove serious.

THE USE OF GOOD SEED.

When we come to consider the fact that the seed kernel contains, or should contain, sufficient nutriment to put out and sustain rootlets until these can begin to draw from the soil and thus support the stem, it will be seen at once that any deficiency in the seed will necessarily tend to weaken the plant at the very beginning of its existence. Thus

good seed becomes the first requisite in securing the healthy, vigorous plant that is to be further strengthened and sustained by a well-prepared, fertile soil. It is very clear, then, that all shrunken, dwarfed, or otherwise imperfect kernels should be cleaned out of the seed before it is sown and only the largest and most perfect retained.

CONCLUSION.

Methods for controlling the Hessian fly, the worst pest of the wheat field, in the fall wheat growing sections, may be summarized as follows: Sow the best of seed in thoroughly prepared, fertile soil after the major portion of the fall brood has made its appearance and passed out of existence, and, if possible, sow on ground not devoted to wheat the preceding year.

In the spring-wheat section late seeding will not apply. It seems likely, on the contrary, that the earlier it is sown in spring the less it will suffer from the Hessian fly. But good seed and a well-prepared, fertile soil are as essential there as elsewhere.

Approved:

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